DEVELOPMENT OF MULTIPLE CHANNELS EDF LASERS

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CONTENTS

ABSTRACT

This thesis presents the research work carried out on the development and analysis of single wavelength EDFL and multiple wavelength EDFL. Two types of single wavelength EDF ring laser were studied namely a fixed signal wavelength system and a tuneable signal wavelength system. However, emphasis was given to the first case. The analyses made, were based on the following parameters: pump and signal stability, pump power, reflectivity, EDF length and cavity loss. The influence of each cavity component such as isolator, polarisation controller, attenuator and tuneable filter were also investigated and reported here. Only one type of multiple wavelength EDFL was studied. It was achieved using a multiple cavity approach and a two-ring system was constructed for this study. It is proposed as a two wavelength source by incorporating an output coupler to each ring instead of single common output port. The importance of analysis on the gain matching requirement (loss allowance and gain difference) for simultaneous multiple lasing is emphasised since no finding has been clearly reported and discussed on this matter. In this study the simultaneous tuning range increases to 50nm without any limitation in the wavelength spacing was achieved. The characteristics, elaborated in the multiple wavelength system are tuning range, spacing between the signals, output power, optimum reflectivity for both signals, optimum output power for both signals and threshold pump power. The effect of back reflection was also investigated and was found that fibre laser systems are unaffected by the back reflected signals.

ABSTRAK

Thesis ini membentangkan hasil-hasil kerja peyelidikan yang dilakukan untuk membangun dan menganalisa laser yang dibuat dari gentian optik berErbium (Er^{3+}) yang menghasilkan sinaran cahaya pada satu jarak gelombang dan pelbagai jarak gelombang. Ciri-ciri yang telah dikaji bagi laser yang memancar pada satu jarak gelombang ialah laser berjarak gelombang tetap dan laser berjarak gelombang boleh diubah. Laser berjarak gelombang tetap banyak dibincangkan dengan laser berjarak gelombang tunggal manakala laser berjarak gelombang boleh diubah dibincang dalam bab laser pelbagai jarak gelombang. Analisa yang dilakukan terhadap laser berjarak gelombang tunggal berdasarkan kepada beberapa ciri-ciri penting seperti kebersandaran ciri-cirinya terhadap keadaan pam dan signal, kuasa pengepam, pengawal pengutuban, pelemah kuasa (attenuator), pengecilan arah gerakan cahaya (isolator), penapis boleh diubah, penyuap balik (reflectivity) dan panjang gentian optik berErbium. Sifat-sifat ini adalah penting untuk memahami laser berjarak gelombang tunggal, laser pelbagai jarak gelombang dan lain-lain laser yang rumit sistemnya.

Teknik bagi menghasilkan laser pelbagai jarak gelombang di dalam thesis ini ialah dengan cara membina banyak gelungan tertutup berkongsikan media pengganda (active medium) yang sama. Dua gegelung dibina untuk kes ini dan setiap satunya mempunyai pengkalan pengeluarnya sendiri. Oleh itu ia berfungsi sebagai dua laser yang masing-masing mempunyai dua jarak gelombang. Kami membuktikan bahawa penyesuaian gandaan (gain matching) adalah penting bagi mendapat banyak jarak gelombang secara serentak walaupun tiada laporan dan perbincangan yang jelas sebelumnya. Ciri-ciri baru lain yang juga dikaji ialah julat kebolehgerakan jarak

gelombang, jarak antara dua signal, kuasa keluaran bagi signal, penyuap balik optimum untuk kedua-dua signal, kuasa keluaran optimum untuk kedua-dua signal dan kuasa ambang bagi pam berdasarkan beberapa parameter diatas. Dalam keadaan tertentu kesan dari proses pantulan balikan dan pancaran spontan yang diperbesarkan (ASE) juga diambil kira.

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